THE

Sphygmomanometer

AND

Its Practical Application

PREPARED FOR

Students and Practitioners of Medicine

BY

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Containing One Full Page Plate and Numerous Explanatory Diagrams in the Text

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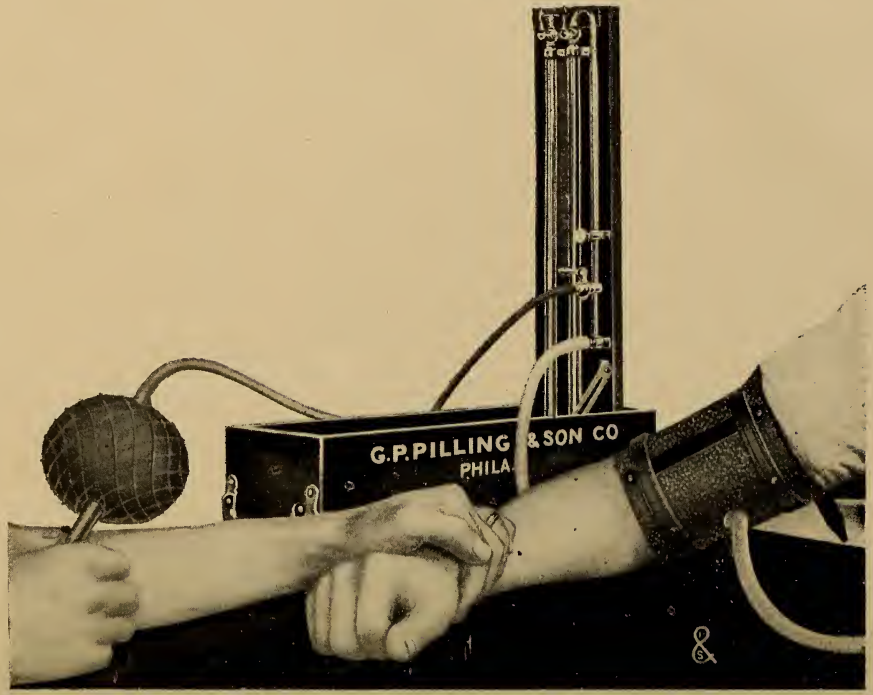

SPHYGMOMANOMETER IN POSITION FOR OBSERVATION

CHAPTER I.

THE CIRCULATION.

A—COURSE OF THE BLOOD.

In 1616 William Harvey published in the notes of his lectures his discovery of the circulation of the blood. Here he states that "a perpetual movement of the blood in a circle is caused by the beat of the Heart."

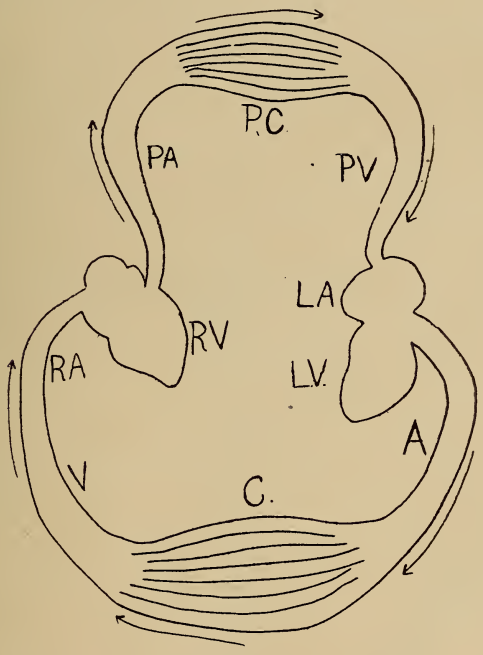

FIG. 1.

FIG. 1. Diagram of Circulation: Arrows indicate the course of the blood; P. A., Pulmonary Artery; P. C., Pulmonary Capillaries; P. V., Pulmonary Veins; L. A., Left Auricle; L. V., Left Ventricle; A., Systemic Arteries; C., Systemic Capillaries; V., Systemic Veins; R. A., Right Auricle; R. V., Right Ventricle. (Redrawn from Am. Text Book of Physiology.)

In the human body we may trace the course of a given particle of blood as it leaves the right ventricle until, having

traversed the entire cardio-vascular system, it returns to the starting point. Referring to Fig. 1 we find the course of the blood to be as follows: From the trunk of the pulmonary artery through a succession of arterial branches into the capillaries of the lungs, from these through the several branches of the pulmonary vein to the left auricle of the heart, thence through the mitral valve to the left ventricle, then by way of the aortic valve to the aorta and the general arterial tree until it finally reaches the capillaries. From the capillaries into the veins back toward the heart, through the vena cavae and into the right auricle, through the tricuspid valve into the right ventricle, through the pulmonary valve into the pulmonary artery, where the tracing of the circuit began.

In brief, the vascular system is a closed series of tubes of varying diameters, including a force pump. This tubular system is partially interrupted at two points by a series of very minute vessels, the capillaries of the lung and of the general circulation.

B—THE FLOW OF BLOOD.

The condition of the arterial walls and the width of the arteries exercise considerable influence upon the flow of blood. If all the arteries of the body were fully dilated it would be absolutely impossible for the heart to maintain the circulation, because the relatively small amount of blood in the body could not begin to completely fill the vessels. The caliber of the arteries is influenced mainly by reflexes coming from various parts of the body, including the heart and the blood vessels themselves. Stimulation of a peripheral nerve will normally cause a reflex contraction which will tend to raise blood pressure.

C—THE CAUSES OF THE FLOW OF BLOOD.

The force by which the blood is driven from the right to the left side of the heart, through the capillaries which are related to the respiratory surface of the lung, is nearly all derived from the contraction of the muscular wall of the right ventricle. The force by which the blood is driven from the left side of the heart through the general circulation, including all the other capillaries in the body, is nearly all de-

rived from the contractions of the muscular wall of the left ventricle. The contraction of the two ventricles is simultaneous. The force generated by the heart in maintaining the circulation is, to a subordinate degree, supplemented by the aspirating action of the chest wall during the respiratory act, by the pumping action of the skeletal muscles and by the elasticity or *tone* of the arteries themselves.

D—MECHANICS OF THE PUMPING MECHANISM.

During each contraction or systole of the ventricles,

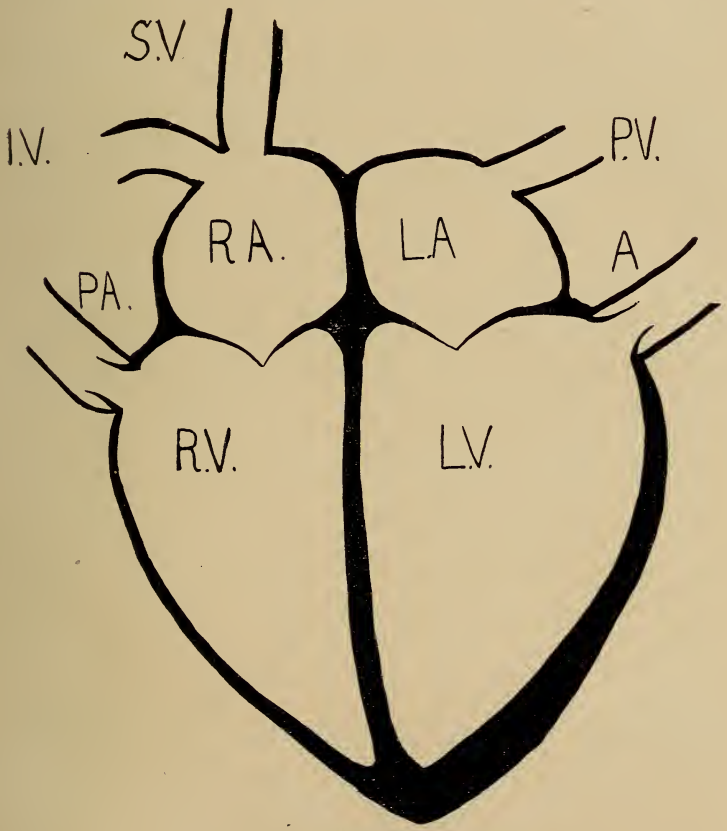

FIG. 2.

FIG. 2. Diagrammatic representation of the cavities of the heart, showing position of the valves during systole: P. A., Pulmonary Artery; P. V., Pulmonary Veins; L. A., Left Auricle; L. V., Left Ventricle; A., Aorta; I. V., Inferior Vena Cava; S. A., Superior Vena Cava; R. A., Right Auricle; R. V., Right Ventricle.

blood is forced into the arteries, only because, at that time, the auriculo-ventricular openings are closed by their respective valves. (Fig. 2.) Immediately following systole, dilitation and relaxation of the walls of the ventricles occur. This constitutes diastole: at this time blood enters the ventricles from the arteries only because during diastole the exits from the ventricles are each closed by a valve which was open during ventricular systole, and because the auriculo-ventricular valves which were closed during ventricular systole are now open.

During the first and longer part of diastole of the ventricles, the auricles are also in diastole and the whole heart is in repose. Near the end of ventricular diastole, a brief simultaneous systole of both auricles occurs, during which they contract and drive the blood which has entered them from the systemic and pulmonary veins, into the ventricles. The systole of the auricles ends immediately before that of the ventricles begins. The brief systole of the auricles is succeeded by their long diastole which corresponds in time with the whole of the ventricular systole and a great part of ventricular diastole. During diastole of the auricles blood is entering them from the veins. Thus it is evident that the direction and force of the blood through the heart is entirely dependent upon the mechanism of the valves at the openings of the ventricles, and that the normal blood pressure is maintained in the circulatory system by the same means, aided by the resistance of the capillaries and the normal tone of the arteries, and that alterations in the circulation, and consequently in blood pressure, are very likely to follow disease of this mechanism, be it either in the valves themselves or in the musculature of the heart chambers.

E—THE CAUSES OF PRESSURE IN THE ARTERIAL SYSTEM.

1—RESISTANCE.

The extensive ramification of the arterial system from the heart to the periphery, culminates in innumerable arterioles on the confines of the capillary system. In the course of the onward flow of blood through this vast system of minute tubules considerable friction is generated between

the blood and the vessel walls. The effect of this friction is propagated backward according to the physics of fluid pressure, and constitutes a strong force of resistance to the outward movement of blood from the heart itself. Thus at each ventricular systole the heart must raise the pressure within its cavity to a point higher than that existing in the aorta before it can deliver its charge through the aortic orifice.

2—Power.

Where the aorta springs from the heart the rhythmic contraction of the left ventricle opens the aortic leaflets and forces intermittent charges of blood into the arterial system. The walls of the arteries are everywhere elastic and therefore expand under the force of this sudden increase in pressure, thus some of the energy expended by the heart becomes potential in the stretched arterial walls.

3—Elasticity.

That the pressure in the arterial system is continuous, depends upon the capacity of the vessel walls for distension under sudden stress and gradual contraction as the pressure within the vessel is lowered by the onward passage of blood through the capillaries.

F—BLOOD PRESSURE REGULATING MECHANISM.

Normal blood pressure depends upon the normal correlation and interaction of certain variable factors. 1—The amount of blood pumped into the arterial system by the heart. 2—The resistance offered to the escape of blood toward the periphery through the smaller arteries and the capillaries. Of less importance are (3) the elasticity of the vessel walls and (4) the total quantity of blood in the body. These factors are all capable of interaction in the most complicated manner. For example, if the arterial pressure is increased from any cause, the vagus nerve is stimulated, and the effect of its inhibitory action upon the heart is to lower the heart rate so that less blood is delivered into the aorta in a given time, thus assisting to maintain normal blood pressure. In like manner when the volume of blood is rapidly reduced from hemorrhage or venesection, the blood-vessel reflex immediately reduces the calibre, so that within certain limits the blood pressure is not altered.

ARTERIAL TONUS.

It is recognized that the normal degree of contraction of the arteries—their tonus is mainly dependent upon nervous impulses which the vessels receive. Recent observations have also demonstrated an independent muscular tone which controls the contraction of the arterial muscular coat, thereby maintaining some degree of contraction entirely independent of reflex action.

If the arteries leading to any part of the body dilate or contract the blood supply to that part will be altered. It is important to remember in this connection that if the tonus of extensive vascular areas is altered the effect is not as easily neutralized as when small areas are involved, and, therefore, the general blood pressure will be affected. For this reason the condition of the numerous abdominal vessels, innervated by the splanchnic nerves—the so-called splanchnic area, on account of their great capacity when dilated, are of vital importance in the maintenance of normal blood pressure.

G—BALANCE OF THE FACTORS IN MAINTAINING ARTERIAL PRESSURE.

Considering a partially filled arterial system let us observe what occurs when a volume of blood is projected into this system by the ventricular systoles. In the beginning the elastic walls of the vessels make room for this charge by expanding, while some accommodation is obtained by the onward passage of blood toward the capillaries. Since it is easier for the arteries to expand than for the whole mass of blood to pass on through the capillaries, the increments of blood are largely stored in the arterial system, thereby tending, by the increasing tension of the arterial walls, to increase blood pressure. Up to a certain point it is easier for the accommodation to occur by further expansion. When the capacity of the arteries to expand under pressure is approached the stretched muscular coat will become tense and stiff. Now at this point each systole will drive a larger portion of the blood forward through the capillaries, and an increasingly smaller amount will be stored in the vessels by a further yielding of the wall. Normal conditions of pressure will be reached and maintained when the blood accom-

modated at each systole by arterial expansion exactly equals the amount of blood passing through the capillaries during the cardiac cycle. When this balance of forces occurs the blood pressure will be maintained at normal.

Anything altering this relation, either by increasing the output of the ventricle or by obstructing the flow through the capillaries, or vise versa, will cause the blood pressure to change. The same is true of alterations in the normal elasticity of the arterial system.

Thus during each cardiac cycle, the heart muscle does work in maintaining the capillary flow against capillary resistance, and in causing expansion of the arterial wall. A part of the manifest energy of the heart thus becomes for a time potential in the stretched fibres of the arterial wall. The moment that a systole is at an end, the stretched elastic fibres recoil, and continue the work of the heart in maintaining the arterial flow against capillary resistance. As this potential energy becomes expanded the pressure gradually falls and it would eventually reach zero were it not for the rhythmically recurring cardiac systole which causes the pressure to again rise.

H—METHOD OF STUDYING BLOOD PRESSURE.

The use of manometers or upright tubes filled with fluid, in the study and measurement of blood pressure in man is attributed to an English clergyman, Stephen Hales,[1] who published the results of his experiments in 1733.

I—THE MANOMETER.

The height of the manometric column is the true measure of the pressure which supports it. The height of this sustained column will, according to the laws of physics, vary with the nature of the fluid composing the column. For example, a given pressure will sustain a column of water of greater height than a column of blood, and the column of mercury sustained by the same pressure will be much shorter than the column of blood.

On account of the difficulties in the way of cloting, and the fact that in man it is impracticable to employ the

(1) Statistical Essays, London, 1733, vol. ii. p. 1.

direct method, therefore the use of a column of blood must be reserved for use in the physiologic laboratory. By the indirect method a column of water may be successfully used, but is not practical because of the great length of tube needed to contain the water even with normal pressures.

In 1828 a French physician named Poiseuille[2] devised a method of using a fluid heavier than either water or blood. He thereby secured a manageable manometer, a longer period of observation and a shorter column.

THE MERCURY MANOMETER.

The mercury manometer of to-day is a modification of the original made by Poiseuille. (Fig. 3.) In its improved

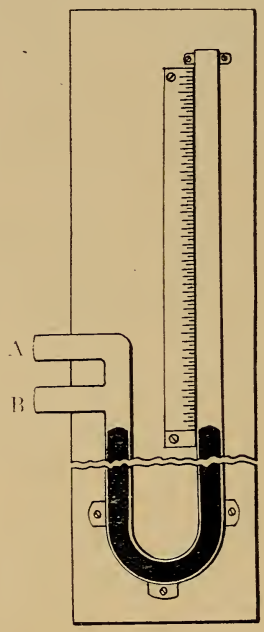

FIG. 3.

FIG. 3. Type of Mercury Manometer, employing "U" tube; A and B are for connection with the Armlet and Bellows respectively.

form it consists of a glass tube open at both ends, bent into the form of an "U" with long limbs. This is securely fastened in a vertical position, partly filled with mercury, and fitted with a millimeter scale to measure the height of the mercury column.

(2) J. L. M. Poiseuille "Recherches sur la force du cœur aortique." Paris, 1828.

J—THE ARTERIAL PULSE.

The increase of arterial pressure occurring at the peak of each ventricular systole and the diminishing pressure occurring during diastole constitute the main phenomena in the production of the arterial pulse. This fluctuation is shown in the manometer by a rhythmic oscillation of the mercury column synchronous with the beat of the heart.

The arterial pressure and the pulse are maintained by and are dependent upon the volume and frequency of the charges of blood sent by the heart into the arterial system, and by the friction of the vessel walls and their elasticity.

Upon a knowledge of these physiologic facts, and the infinite variations to which they are subject, is based our knowledge of the pathology of the circulation and of blood pressure.

CHAPTER II.

BLOOD PRESSURE. CLINICAL VIEW. DEFINITIONS. CAPILLARY BLOOD PRESSURE.

The pressure of the blood in the capillaries is low because of the resistance offered to the progress of the blood by the fine bore of the vessels, and because of the relative large cross sectional area of all the capillaries compared to that of the aorta and great vessels.

If one press with a blunt object upon the skin just below the matrix of the finger nail, the ruddy surface becomes pale because the capillaries are flattened by the force applied and the blood driven out of them. If delicate weights or a spring be used to apply the pressure, then the force which is just sufficient to whiten the tissues can be measured, and the amount of pressure which approximately counterbalances the pressure within the capillaries can be definitely determined.

The capillary pressure, measured by this means, has been found to be much lower than in the arteries, and considerably higher than the pressure in the great veins. This pressure has been found to equal that required to sustain a column of from 24 to 54 millimeters of mercury.[3]

Terms and Definitions.

Having studied the physiology of the normal circulation, and the causes concerned in the production and maintenance of blood pressure, we may now proceed to a consideration of the relation of these facts to the problems of clinical medicine, and their bearing on Diagnosis, Prognosis and Treatment.

To obtain a clear insight and understanding of the subject it is all important to have an accurate knowledge of the terms applied to the matter under consideration.

The Pulse. Is the rhythmically recurring impulse propagated by the systole of the left ventricle and palpable throughout the arterial system.

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(3) Am. Joun. of Physiol. p. 377.

Arterial Pressure. By arterial pressure is meant the degree of force exerted by the blood within the vessel. It is primarily dependent on the strength of the heart as measured by its rate and by the volume of blood expelled at each systole, balanced by the elasticity of the vessel walls and capillary resistance.

The Systolic Blood Pressure. (Fig. 4.) The systolic pressure as indicated by the sphygmomanometer, rep-

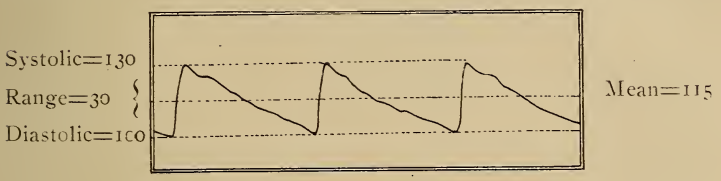


Fig. 4.

Fig. 4. Normal Pulse Tracing: showing relation of Systolic, Diastolic, Pulse Pressure C, and Mean. Pulse Pressure equals 30.

resents the pressure within the vessels at the time of systole of the ventricles.

The Diastolic Pressure. (Fig. 4.) The diastolic pressure represents the ebb to which the arterial pressure falls during cardiac diastole.

The Pulse Pressure. Range or Amplitude (Klemper) (Fig. 4.). The arterial pulse is caused by variations in pressure within the arterial system caused by the intermittent pumping action of the heart. The difference between systolic and diastolic pressure, i. e., the variation in pressure occurring within the vessel during a complete cardiac cycle, is termed the pulse pressure. This figure is obtained by subtracting the diastolic from the systolic pressure. *The normal pulse pressure ranges between* 20 *and* 30 *millimeters of mercury.*

Variations in the pulse pressure in the same individual constitute a most important part of the study of blood pressure.

It is theoretically possible that the pulse pressure should be influenced in at least three ways. 1—An increase in the amount of blood delivered at each beat of the heart would tend to increase the difference between systolic and diastolic pressures.

2—A rapid emptying of the vessels, the cardiac output remaining the same, would tend to increase this difference. This would occur independently of whether the blood was passed onward into the capillaries or was regurgitated back into the ventricle.

3—Rigid vessel walls would influence pulse pressure. If the arteries were rigid tubes, the heart at each systole would be compelled to move the blood in the arterial system as a whole, while during diastole the flow would cease. There would thus be an increase of pressure during systole, while during diastole it must fall almost to zero.

THE MEAN PRESSURE. The mean blood pressure is valuable chiefly as an indication of the amount of strain to which the heart and larger vessels are subjected. It varies with the pulse pressure, the systolic pressure and the diastolic pressure.

To obtain the mean pressure, divide the sum of the systolic and diastolic pressures by two or add half of the pulse pressure to the diastolic pressure (see page 13).

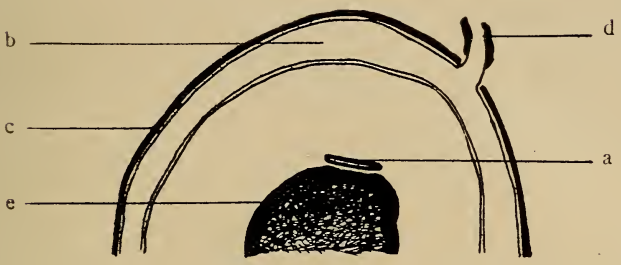
Pathologically, the pulse pressure increases in organic diseases of the kidneys, in arterio-sclerosis and in aortic insufficiency. It diminishes from other organic diseases of the heart, affecting the valves or myocardium.[4] It is noted that in the healthy the pulse pressure increases with moderate exertion, while every deficiency in the circulation shows itself by a reduction in the pulse pressure even when the systolic pressure is increased. This fact makes it possible to differentiate certain nervous disturbances of the heart from those of organic origin.

According to Gerhardt the systolic pressure in broken compensation may be high, but the pulse pressure always becomes small as the heart grows weak and becomes greater again when the power of the contraction is improved.

THE PRINCIPLE OF THE SPHYGMOMANOMETER.

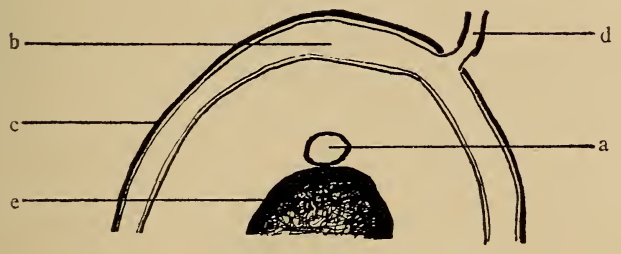
Vital tissue is perfectly elastic. Therefore any pressure applied to the surface of the body will be directly transmitted to the underlying structures without loss of force. It is upon this principle that the indirect method of measuring the blood pressure is based.

(4) Elchberg Jour. A. M. A. Sept. 19, 1908.



A

A.—Pressure in "b" 135 mm.Hg., pressure in "a" 130 mm.Hg., B is therefore collapsed, pulse cannot pass.

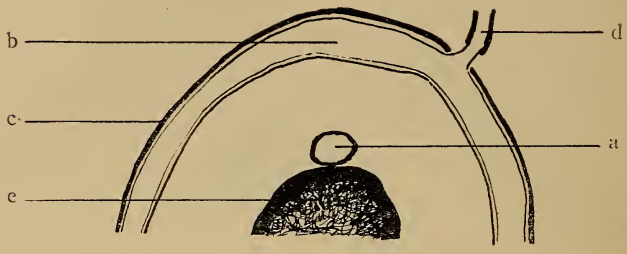


B

B.—Pressure "b" 129 mm.Hg., pressure in "a" 130 mm.Hg., pulse passes.

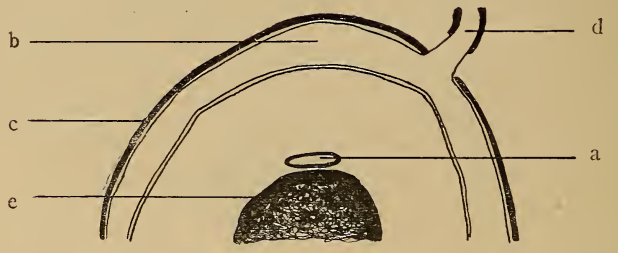
FIG. 5.

FIG. 5. Diagram of Relations of Armlet to Brachial Artery. Explanation of systolic reading: a, artery; b, compressing armlet; c, retaining cuff; d, tube to manometer; e, humerus.



A

A.—Systolic pressure in "a" 130 mm.Hg., pressure in "b" 101 mm.Hg., artery not compressed.



B

B.—Diastolic pressure in "a" 100 mm.Hg., pressure in "b" 101 mm.Hg., artery collapsed.

FIG. 6.

FIG. 6. Diagram of Relation of Armlet to Brachial Artery. Explanation of diastolic reading; a, artery; b, compressing armlet; c, retaining cuff; d, tube to manometer; e, humerus.

Pressure is applied to an accessible part of the body over a large blood vessel such as the brachial. If the amount of this pressure is sufficient to overcome the pressure of the blood within the vessel, the vessel will be collapsed and the pulse prevented from passing beyond it. If the amount of the compressing force is measured and expressed in definite terms of weight (as millimeters of a column of mercury) then we can, by applying just sufficient pressure to collapse the vessel, measure the amount of force exerted by the blood in preventing this collapse.

In practice the pressure is produced by a cautery bulb or a small hand pump, and applied to the arm by means of a hollow flat rubber bag. This is applied about the arm and held there by some form of inelastic cuff. Communication with a mercury manometer measures the amount of pressure applied to the vessel.

EXPLANATION OF THE SYSTOLIC READING.

Figure 5, A and B, shows the relation of the compressing bag to the artery. In Figure A, the pressure within the cuff is greater than the blood pressure within the artery, which is therefore collapsed and the pulse in the distal end of the vessel cut off. In Figure B, the pressure in the cuff has been reduced so that it is a fraction of a millimeter less than the systolic pressure within the vessel. Now at each systole a small amount of blood will pass the constriction and will reach the distal end of the artery, where the wave can be felt by the palpitating finger at the wrist.

EXPLANATION OF THE DIASTOLIC READING.

Figure 6, A and B, represents the conditions existing between the constricting cuff and the vessel at the diastolic time of pressure. A represents a pressure within the cuff less than the sytolic pressure in the vessel. This is insufficient to affect the vessel during the systolic period. B shows the artery and cuff during the diastolic period, when

the pressure within the artery at its lowest point, a fraction of a millimeter less than the pressure within the cuff. Consequently the artery is collapsed at this time. The effect of each succeeding systole is to alternate between a round and a flat vessel at the point of compression. This affects the pressure of air within the cuff which is in turn transmitted to the mercury column of the manometer and becomes visible in the rhythmic fluctuation of the column of mercury which is synchronous with the pulse beat. Since the fluctuation will reach a maximum at the time when the

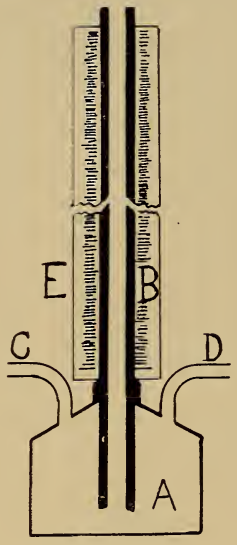


FIG. 7

FIG. 7. Type of Mercury Manometer employing a vertical tube: A, Mercury-containing base; B, Manometer tube; C, tube to armlet; D, tube to bellows; E, scale.

pressure in the cuff is approximately equal to the diastolic pressure in the vessel, we are justified in considering the base of the manometer column at this time a measure of the diastolic pressure within the vessel.

THE SPHYGMOMANOMETER, METHOD OF USING AND RECORDING FINDINGS.

Since the recent general adoption of the blood pressure test, many forms of sphygmomanometer have been de-

vised in an effort to produce a durable, accurate and portable instrument.

These instruments may be roughly divided into two classes. Those dependent upon the height of a fluid column for measuring the pressure, and those employing some form of spring or anæroid chamber.

Generally speaking, there are two types of mercury (fluid column) instrument. One of these employs a vertical tube into which the mercury column is forced from a large containing chamber in the base of the instrument. The pressure is measured in millimeters of mercury on an appropriate scale attached to the vertical glass tube. (See Fig. 7.)

The other employs a glass tube (similar to that first used by Poiseuille) (see page 10) bent in the form of a "U" with the open ends up. This tube is partly filled with mercury and one end connected by means of suitable tubing with the compression part of the apparatus. The degree of pressure is measured upon a suitable scale placed between the two limbs of the tube, the pressure being represented by the difference in the height of the mercury in the two limbs of the "U" tube. (See Fig. 3.)

Attempts to produce an instrument of pocket size which might easily be carried by the physician, led to the introduction of the spring types of instrument above referred to.

While these spring and anæroid instruments have much to recommend them in the way of compactness and portability, unfortunately this feature is more than offset by their inaccuracy and the variability of the readings obtained with them. Variations amounting to more than 30 millimeters of mercury have been noted in instruments of this type.

This difficulty makes it necessary for users of them to frequently check and correct their instruments with a standard mercury manometer.

The sphygmomanometer bearing the author's name is modelled after the type of apparatus employing the "U" tube and is designed to overcome the many shortcomings of the earlier instruments and to furnish an instrument which is easy to use, difficult to get out of order, accurate

and as light and portable as is compatible with exactness and strength.

The mahogany case, which encloses the complete apparatus, including the arm-band and pump (See Fig. 8) measures

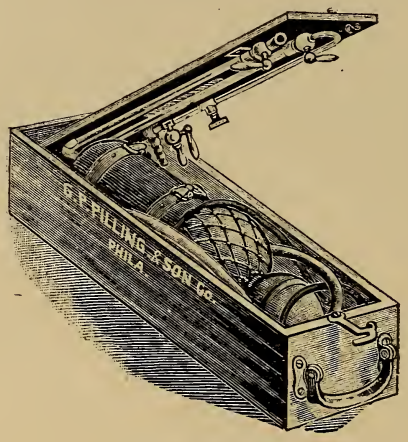


FIG. 8.

Faught Sphygmomanometer. Packed for transportation.

4 x 4½ x 16 inches and weighs 3 pounds 9 ounces. The lid is hinged at one end and when raised supports the working parts of the apparatus. A spring check allows the lid to be raised to a vertical position, where it is automatically held locked during the observation.

The "U" tube is provided with a scale which has been arranged to give the reading directly in millimeters of mercury.

A special and distinctive feature of the apparatus is the means of preventing loss of mercury from the manometer tube when the instrument is not in use. This is accomplished by means of two small cocks placed at either extremity of the "U" tube, and which are kept closed when the apparatus is not in use.

By eliminating all detachable parts, the time required to make the reading is reduced to a minimum. The only preliminaries to the test being to lift the lid, open three cocks and attach two tubes to their respective nipples.

DIRECTIONS FOR OPERATING THE SPHYGMOMANOMETER. (Fig. 9.)

The patient should be in a comfortable position, and in a sitting or reclining posture. The instrument should be upon a level surface within easy reach of the examiner.

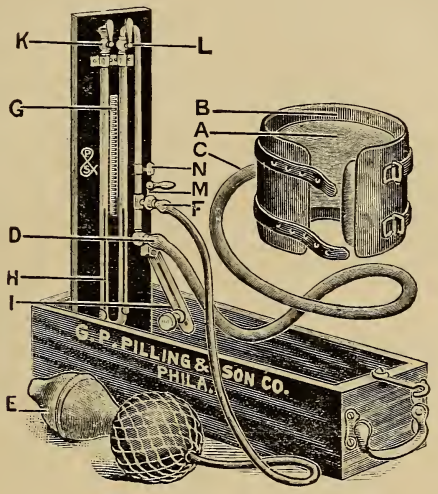


Fig. 9.

A Inner Arm Bag. B Outer Arm Band. C Tube from Arm Band. D Nipple for tube from Arm Band. E Hand-Bellows. F Nipple for Bellows Tube. G Millimeter Scale. H Manometer Tube. I Link-Brace and Lock. K Mercury Guard Cock. L Mercury Guard Cock. M Pressure Guard Cock. N Release Valve.

The lid is then raised until it locks in a vertical position. If the tube from the hand bellows is not already connected to the nipple F it should be firmly attached to it. The two mercury guard cocks K and L at the ends of the "U" tube should be opened and the escape valve N tightly closed.

The hollow rubber bag of the arm-band A should be firmly wrapped around the bared arm of the patient and securely bound there by the leather cuff and straps B. (See Frontispiece.) The cuff should be applied snugly, but not with pressure, as it is not designed to compress the member, but only to restrain the inner rubber bag while pressure is applied to it.

The tube from the arm-band C is attached firmly to the nipple D. The cock in the nipple F is opened.

This arrangement forms a continuous closed pneumatic system communicating freely with the manometer tube of the instrument. Now when pressure is raised in the arm-band by the hand bellows, the amount of force exerted is indicated by the rise of the right hand column in the manometer tube H, the height of which will be indicated on the scale G in millimeters of mercury.

To Obtain the Systolic Reading.

With one hand find the pulse at the wrist of the arm, to which the arm-band has been applied. The fingers should be in a comfortable position and under no circumstance should be moved during the observation. Care should also be observed that the pulse is not cut off by undue pressure of the palpitating fingers.

While the pulse is thus under observation, the pressure in the apparatus is raised by means of the hand bellows or pump until the pressure within the constricting band is sufficient to prevent the impulse from reaching the wrist. When this is accomplished the cock in the nipple M is closed to eliminate the elastic pressure of the hand bellows. Now by a fraction of a turn in the valve N the pressure in the system is slowly released. During this part of the procedure, a close watch should be kept upon the height of the mercury column and for the return of the first pulse beat at the wrist. The level of the mercury column at the instant that the pulse passes the compression-band will represent the systolic pressure of the patient under observation. It is advisable to repeat this procedure a few times to check the correctness of the finding.

To Obtain the Diastolic Pressure.

This may be accomplished in two ways. Of these, the second, will be found very valuable in case of small arteries or when the tension is low, on which occasions the diastolic wave is not perceptible.

First Method. This depends on the to-and-fro motion imparted to the mercury in the "U" tube which occurs after the pressure has fallen below the systolic point and is synchronous with the pulse beat. Having determined the systolic pressure again raise the pressure to a few millimeters above this point and immediately close the valve M. Now allow the pressure to fall very slowly by releasing the valve N.

As the mercury falls below the systolic point it will be noted that it acquires a rhythmic motion corresponding in time to the pulse. This will be found to gradually increase in amplitude up to a certain point, after which it decreases and finally ceases before zero pressure is reached. During this gradual fall, the bases of the mercury column, when the mercury is making the greatest excursion, represents the diastolic pressure.

Second Method. Raise the pressure within the apparatus to the systolic point, then, while keeping the fingers in touch with the pulse, allow the mercury column to gradually fall as in the first method. It will then be noted that at first the pulse is very feeble and thready in character and continues so for a time, then as the pressure falls it will suddenly assume the full bounding character of the pulse of aortic regurgitation. At the moment when this change occurs the height of the mercury column will represent the diastolic pressure in millimeters of mercury. (For explanation of this phenomenon see page 17.)

Cautions. To obtain accurate and reliable clinical data with the sphygmomanometer, it is important that some systematic technic be adhered to, and that all observations not only on the same patient, but in all cases be made under as nearly the same conditions as possible. Attention to such details will eliminate largely the errors arising from such factors as position of the patient, presence of fatigue or mental excitement, arm used for observation, etc. It is also important to note the apparatus used, the time of day, the pulse rate, the age and sex of the patient. These should all be recorded in a chart prepared for this purpose.

The following printed form has been taken from the author's work on Laboratory Diagnosis,[5] which has been found useful in keeping records of blood pressure tests.

Care should also be taken to see that the observation is not too prolonged, for the interruption of the circulation in the extremity will, if continued, itself cause changes in pressure.

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(5) Essentials of Laboratory Diagnosis. F. A. Faught. F. A. Davis Co. 1909.

No single reading should be accepted when it is possible to make more than one. It is better to see the patient a number of times under varying conditions before deciding what his blood pressure is.

BLOOD-PRESSURE DETERMINATIONS.

Clinical Report.

....

....

Apparatus {

Width of Cuff cm.

Part examined,

Right,

Left,

Posture,

Pulse Rate,

Systolic	mm. Hg.	after 10 Bending Movements.				mm. Hg.
Diastolic	mm. Hg.	"	"	"	"	"
Pulse Pressure	mm. Hg.	"	"	"	"	"
Mean Pressure	mm. Hg.	"	"	"	"	"

Remarks.

Time of Day. A. M..... P. M.....

Date .....

Examined by.....

CHAPTER III.

THE NORMAL BLOOD PRESSURE.

Experimental study and clinical observation have established within fairly well defined limits, the normal blood pressure in man, and also the extent of what may be termed the *physiologic variation*. That is, the extent to which the normal reading may be modified by age, sex, exercise, time of day, altitude, posture and pulse rate. The immediate effects of alcohol and tobacco have also been determined.

REPORTS OF DIFFERENT OBSERVERS ON BLOOD PRESSURE.

The Normal Systolic Variation.

Faure. Direct measurement,	110 to 160	mm. Hg.
Albert. Direct measurement,	100 to 160	"
V. Basch. Indirect measurement,	110 to 150	"
Bruce. Indirect measurement,	100 to 130	"
Graupier. Indirect measurement,	115 to 125	"
Jellinek. On 500 healthy soldiers,	100 to 150	"
Sahli. High limit of health,	135	"
Hansen. Indirect measurement,	100 to 160	"
Hansen. Mean average,	137	"
Gumprecht. Indirect measurement,	120 to 140	"

These figures represent the work of a number of careful observers, under diverse conditions, in different countries and with a variety of apparatus. They may, therefore, be taken to represent with a fair degree of accuracy the limits of the normal systolic variation. That they are a little too wide must be conceded when it is remembered that they were obtained with different instruments and different widths of cuff. Omitting the two single figures of Hansen and Sahli, the average of the remaining eight observers is from 106 to 146 millimeters of mercury.

In a limited series of observations by the author employing a 10 centimeter cuff upon a few healthy adults who may be taken to be fair examples of the average city dweller, the systolic variations did not extend beyond 115 to 142 millimeters of mercury. (See page 31.)

These observations were made under a great variety of conditions, including different times of day, before and after eating, and during digestion, exercise, brain work, and rest, and before and after the moderate use of alcohol and tobacco.

From the foregoing it would seem safe for the present to adopt as the normal limits of systolic variation in young, healthy adults of 100 to 145 millimeters of mercury.

SEX. It is generally accepted that the systolic pressure in women is lower than in men under the same circumstances. Lauder Brunton[6] states that he has found the systolic pressure in women to be from 10 to 15 millimeters lower than in man. Other definite figures on this point are wanting. The difference is at best of but little importance, since we recognize no one pressure as standard, our chief concern being the variations occurring in the same individual at different times, and under different conditions.

POSTURE. The following series of observations were made upon 22 healthy medical students:[7]

10 CENTIMETER CUFF. PRESSURE IN MILLIMETERS OF MERCURY.

SYSTOLIC PRESSURE AND PULSE RATE.

SYSTOLIC PRESSURE	STANDING.	SITTING.	SUPINE	HEAD DOWN.	RIGHT LATERAL.	LEFT LATERAL
Right arm	132.6	133.3	152.5	166.2	155.0	110.0
Average	130.8	131.7	150.4	165.6	143.5	133.0
Left arm	130.0	130.0	128.3	165.0	114.0	156.0
Pulse rate	86	82	68.7	65.8	68.1	69.1

Summary of observations upon the effect of posture upon the systolic and diastolic pressures.[8]

SYSTOLIC AND DIASTOLIC PRESSURES.

		STANDING.	SITTING.	SUPINE.	HEAD DOWN.
1—Arm	Systolic	84	90	94	100
	Diastolic	70	70	76	80
2—Arm	Systolic	126	124	132	134
	Diastolic	110	110	112	115

(6) Lancet, October 17, 1903.
(7) O. Z. Stephens, Jour. A. M. A. Oct. 1, 1904.
(8) Sandford, Jour. A. M. A. Feb. 15, 1908.

From these observations the following conclusions can be drawn as to the effect of posture upon blood pressure, pulse pressure and pulse rate.

(1) Posture affects both the systolic and diastolic blood pressure.

(2) The blood pressure rises in the brachials from the standing to the head down posture in the following order:— Standing, sitting, left lateral, right lateral, supine and head down.

(3) The pulse rate is decreased in the same order that the blood pressure is increased.

(4) The increase in pressure is accompanied by an increase in heart strength.

(5) The pulse pressure increases from the standing to the head down posture.

(6) The decrease in pulse rate is a conservative act of nature to protect the heart itself and the central nervous system.

(7) The average systolic pressure in the sitting posture is normally a few millimeters above that of standing.

AGE. During the first years of life the systolic blood pressure varies from 75 to 90 millimeters of mercury.[9]

According to the observations of Lauder Brunton[10] the maximum pressure in children from 8 to 14 years is 90 millimeters of mercury. In youth between 15 and 21 years, 100 to 115 or 120 mm.Hg. In adults between 21 and 65 years, the systolic pressure should be from 120 or 125 to 135 or 150 millimeters of mercury. Above 65 years it may still remain between 153 to 150, or owing to senile changes in the arterial system go up to 180 or even higher. In women as a rule the pressure is from 10 to 15 millimeters lower. In strong, athletic men the pressure is usually somewhat higher, about 10 or 15 millimeters more than in men of ordinary physique.

BLOOD PRESSURE IN CHILDREN. According to W. L. Stowell,[11] the following is a summary of our knowledge of the blood pressure in children:

(1) Blood pressure in the young is low in proportion to extreme youth.

(9) Krehl. Clinical Path.
(10) Lanct. Oct. 17, 1903.
(11) Arch. of Pediat. Feb., 1908.

(2) Its rise and fall are more quickly influenced by emotions than in adults.

(3) Diseases of the nervous system give heightened pressure.

(4) As a general rule blood pressure observations in children are of physiologic interest, but have little clinical value.

TIME OF DAY. In the early hours of sleep there is a decided fall in blood pressure which gradually rises toward morning.[12] The pressure will be found to approximate the minimum in the early part of the day, approaching the maximum as the day passes.

DIGESTION. Evidence bearing on the effect of normal ingestion of food and the act of digestion is not very abundant. It is generally believed that these cause a slight elevation of blood pressure lasting from one to three hours. The effect of improper eating and disturbances in the digestive tract will be considered later. (See page 31.)

ALTITUDE. The observations of Peters,[13] made at an altitude of 6,000 feet, seem to show that height has an important bearing on the height of blood pressure, his tables showing that blood pressure normally rises with increasing altitude. He believes that this fact has a close bearing on the value of altitude in the treatment of pulmonary tuberculosis. The elevation in pressure occurring at high altitudes probably has much to do with the distressing effect of travel in high altitudes upon patients with defective cardio-vascular systems.

EXERCISE. Muscular exertion raises temporarily the blood pressure. (See page 38.) This rise becomes less marked as the individual becomes accustomed to performing that particular act or acts. This gradual reduction in the susceptability of the vascular system is one of the beneficial effects of training.

When effort is prolonged but moderate the pressure rises, but soon adjusts itself to a mean high level, on which any additional increase in effort produces no further rise.[14]

(12) Brush and Fairweather, Am. Jour. of Physiol. Vol. v, p. 1??.
(13) L. Peters, Archives of Int. Med. Aug., 1908.
(14) Eichberg, loc. cit.

During exercise (in the healthy) the systolic and diastolic pressures tend to become more widely separated, i. e., the pulse pressure becomes greater.[15] (See also page 40.)

G. Weiss[16] believes that the blood pressure may be modified to such an extent by both exercise and emotion, that even a brief walk to the office may markedly affect the reading. This fact is important. By recognizing this we can readily appreciate the importance of enforcing a brief rest and a tranquil mind upon a patient who may have been walking briskly, or who is agitated by apprehension of the approaching examination, before applying the test.

Passive movements, except those causing pressure upon the thorax or abdomen, can be prolonged without causing material rise in the blood pressure.[17]

EMOTION AND EXCITEMENT (pain). In discussing the rise in blood pressure in relation to emotional factors, Norris[18] says that, "It is little realized by the profession how great an influence aberrance of blood supply may have upon the mood, mental poise, apathy and physical beneficence of an individual." On the other hand he notes that the effect of pain, fright and mental excitement in producing increased tension must always be borne in mind when making blood pressure observations.

According to G. Weiss (loc. cit.) the blood pressure may be modified to such an extent by exercise or emotion, that even a brief walk to the office, or apprehension of the procedure, or vaso-motor disturbance from prolonged pressure, or sensations of heat or cold, or other causes of vaso-constriction or vaso-dilatation, even in a single member, may modify deceptively the arterial pressure.

The importance of the bearing of these modifying influences must never be overlooked. The circumstances surrounding the test, the despatch with which it is carried out, and the proper understanding between patient and examiner must all be considered. Only by this means will the many deceptive influences be prevented and the accuracy of the reading be assured.

(15) Krehl. loc. cit.
(16) Presse Medicale, 2, Sept., 1908.
(17) Eichberg, loc. cit.
(18) G. W. Norris, U. of P. Med. Bull., April, 1908.

As bordering on the physiologic, by reason of their universal use, a brief consideration of the effect of alcohol and tobacco upon blood pressure will be considered here.

ALCOHOL AND TOBACCO.

It is important to have a clear conception of the immediate effect of a moderate use of alcohol and tobacco in order to appreciate the pathologic changes resulting from long continued use of these drugs.

ALCOHOL.

From clinical evidence it appears that the effect of a moderate amount of alcohol even when taken habitually, does not cause any marked influence upon the pressure level. On the other hand it seems equally evident that the continued employment of even moderate amounts of alcoholic drinks, plus over indulgence in eating and carelessness toward proper elimination, will eventually bring about changes in the circulation which show themselves in a permanent increase in blood pressure.

In this connection Russell[19] reaches the following conclusion: "We may consider it to be generally accepted that generous feeding and the free use of alcohol leads to a condition of the pulse which is termed 'High tension,' especially if there is not daily a free evacuation of the bowels."

TOBACCO.

H. A. Hare in a prize essay published about 20 years ago, reports a careful and critical study of the effect of nicotine upon blood pressure. In this essay he concludes that a small amount of tobacco (smoking) in the normal person accustomed to its moderate use, causes a sedative action accompanied by a lowering of blood pressure, while tobacco in excess causes a secondary rise in the pressure. This is in substance all that we know to-day, in spite of the improved methods of observation now at our disposal.

More recent observations[20] conclude that the evidence at hand does not lend support to the theory that smoking is an etiologic factor in the production of arteriosclerosis, at least in so far as the theory assumes injury to the vessels.

(19) Wm. Russell, Arterio-Sclerosis, Hypertonus and Blood Pressure, 1908.
(20) Bruce, Miller and Hooker, Am. Jour. of Physiol., April, 1909.

The following figures from some personal observations are also in accord with the bulk of records bearing on this point.

These records were made immediately before and after smoking a varying number of cigars at different times during the day. The figures given are the systolic reading, taken in the sitting position:

Before smoking	138	after	1	cigar	130					
" "	130	"	3	"	138					
" "	140	"	1	"	130	after	2	cigars	132	
" "	122	"	1	"	122	"	4	"	132	
" "	128	"	3	"	130					
" "	122	1 and	dinner		135	"	5	"	130	
" "	120	after	5	cigars	130					
" "	125	"	5	"	128					
" "	118	"	2	"	120					
" "	130	"	1	"	124					

The safe and logical conclusion as to the effect of tobacco on a man accustomed to its use, is that it affects the pressure no more than those other stimuli which are the necessary consequence of civilized life.

ALIMENTARY HYPERTENSION.

It has long been recognized that certain conditions of the circulatory system, accompanied by alterations in the character of the pulse, originate from disturbances in the digestive tract.

This change usually shows itself in an increase of vascular tension, due to a tightening up of the musculature of the arterial walls caused by a reflex emanating from the splanchnic area. (See page 8.) In a certain degree this is a normal reflex and its action is noted in the normal individual of proper habits of eating and elimination. When it becomes pathologic we find that there are added factors which cause this elevation in pressure to become excessive and to be prolonged.

Individuals exhibiting this condition usually belong to one of two types. One is seen in the person with florid face, bulky frame and full, strong pulse. The other may not show the evidences of excessive indulgence so plainly, but will be found to be subject to more or less frequent attacks of "biliousness" or "torpid liver."

This inter-relation between the digestive process and elevated blood pressure has long formed the basis for treatment, which usually consists of free unloading of the digestive tract, together with a reduction in the amount and alteration in the variety of food and fluids taken. The subsidence of excessive pressure is usually prompt after such measures.

This combination not infrequently forms the entering wedge which finally causes death from cardio-vascular renal disease or apoplexy. The rationale of this complex disturbance in the metabolic processes is complicated and requires careful consideration.

According to the researches of Russell (loc. cit.) our knowledge of the pathology of the condition is as follows:

During the process of digestion there is a normal reflex arising in the splanchnic area and passing to the vasomotor centers in the medulla, which leads to a general arterial contraction. This in normal degree may be termed the physiologic hypertension of digestion. In the pathologic phase, two other factors are also operative. First, the absorption of excessive amounts of the nutritative products of digestion, and the absorption from the intestines of the products of proteid decomposition.

The first of these is the direct result of over eating, coupled with an active digestion; thus more food is converted to the needs of the body than is required for its maintenance, an increased load is placed upon the excretory organs, imperfect nitrogenous waste elimination ensues and a bilious attack is the inevitable result.

In the production of the second factor, the colon group of bacilli act upon the undigested proteid in the intestinal canal, particularly in the large intestine, and set up putrefaction. This pathologic decomposition is further favored by imperfect evacuation of the bowel. The sluggishness of the intestinal canal allows greater time for the absorption of these products, which enter the circulation and act as direct irritants to the muscular coat of the arteries.

These putrefactive products belong to the aromatic series and comprise chiefly the etherial sulphates of indol, skatol and phenol. These are eliminated by the kidneys and appear in the urine as the aromatic sulphate salts of potassium.

The amount of these substances becomes therefore a measure of the amount of absorption of these putrefactive products, and an indication of the amount of disturbance in pressure dependent upon this cause.

The symptoms and degree of discomfort occasioned by the absorption of these poisons varies within extraordinarily wide limits. Some persons are remarkably susceptible to their action; old persons seem to be more susceptible than the young and middle aged. In some instances the manifestations of toxemia are so profound as to constitute a definite idiosyncrasy.

Alimentary hypertension is the result, therefore, of a normal abdomino-arterial reflex, made excessive by overloading of the digestive tract and the absorption of toxic substances from the large intestine.

This hypertension may be the first link in the chain leading to arterio-sclerosis, contracted kidney and apoplexy, particularly if the heart strength be maintained.

This symptom group is often vaguely, for want of a better explanation, *termed gouty, or suppressed gout.* The mental repression, the physical lassitude, and bilious attack are all directly traceable to the hypertension, resulting from the conditions just described.

TREATMENT directed to the underlying causes will cause the symptoms and the hypertension to disappear, and if we are able to modify the patient's dietary and habits, we may succeed in preventing a return of the old conditions as long as the new regime is adhered to.

CHAPTER IV.

PATHOLOGIC VARIATIONS IN BLOOD PRESSURE.

We have seen that the blood pressure is subject to continual and uncertain variations, depending upon, more or less uncontrollable factors. Fortunately these fluctuations are all confined within a definite range which makes it possible to recognize them when these alterations have passed beyond the prescribed normal limits and have entered the range of the pathological. When studied in conjunction with other physical signs and subjective symptoms we are able to obtain valuable aid in differentiating certain diseased conditions, to detect the incidence of untoward complications, and to follow more intelligently the effect of treatment.

For convenience in study we may appropriately divide pathologic alterations in blood pressure into *pathologic high pressure and pathologic low pressure.*

PATHOLOGIC HIGH BLOOD PRESSURE.

High pressure *per se* is not a disease but a phenomenon or symptom, which may accompany a great variety of diseased conditions, including diabetes, gout, syphilis, chronic lead poisoning, cardio-vascular renal disease, many anomalies of nutrition, etc.

Alterations in blood pressure may be brought about by any agent capable of acting upon the muscular or nervous mechanism of the heart and blood vessels, or it may result from sudden changes in the volume of the blood, as in hemorrhage.

Acute Asphyxia and Acute Anemia of the brain (medullary centers) will powerfully stimulate the vasomotors, causing constriction of the splanchnic area and a rise in blood pressure.

Lead Colic affecting the abdominal vessels is usually associated with high blood pressure, as is also the early stage of Peritonitis.[21] Pain, even when slight, as in pinching the skin, usually raises the systolic pressure.

(21) Krehl. Clin. Path. page 11.

Continuous high pressure is seen in certain forms of NEPHRITIS. Thus in primary acute Bright's disease and in nephritis secondary to scarlet fever, there is practically always a marked rise in arterial pressure. A rise amounting to more than 50 mm.Hg. has been observed within 48 hours of the onset of an acute nephritis.[22] Elevated pressure is also found in beginning ARTERIO-SCLEROSIS of the first part of the aorta and of the splanchnic vessels.[23]

In dealing with the elevation of pressure, which is the result of the action of drugs or of toxic agents, it is important to bear in mind that the amount of the substance and its concentration, its potency as well as the duration of its action will determine the amount of elevation, the duration and the permanence of the effect.

Apart from a few specific conditions which are usually accompanied by a marked and usually permanent rise, the majority of the moderate elevations of systolic pressure result from the development of poisons or toxins within the body, from FAULTY OR DEFECTIVE METABOLISM (see page 31) or during the course of MANY INFECTIONS. (See page 49.)

PATHOLOGIC LOW PRESSURE.

A pathologic depression in blood pressure may be caused by the depressing influence of CIRCULATING TOXINS acting either upon the heart blood vessels or controlling nervous mechanism or to sudden withdrawal of a large volume of blood from the circulation, as in HEMORRHAGE, after venesection, copious diaphoresis, diarrhoea, or in shock.

THE LOWEST BLOOD pressure compatible with life has been reported by Neu to be from 40 to 45 millimeters of mercury and this only occurred with subnormal temperature in the moribund state. He has seen recovery after a fall in pressure as low as 50 millimeters.

In general it may be said that lowered blood pressure is of little significance except after hemorrhage or during surgical shock. Here the great and sudden reduction in pressure may be sufficient to immediately endanger life.

It is noted that a moderate and progressive fall in

(22) Buttermann, Arch. of Klin. Med. vol. lxxiv. p. 11.
(23) Krehl. loc. cit.

pressure occurs in most progressive and prolonged fevers, as in typhoid fever. When due to such a cause the depression is rapidly overcome and disappears as convalescence is established.

Widespread dilitation of the vessels and consequent lowering of blood pressure has been noted in the last stages of ARTERIO-SCLEROSIS.[24]

Arterial dilitation and lowering of blood pressure may result from general loss of arterial tone. Thus if the splanchnic vessels become widely dilated and filled with blood, the other arteries are insufficiently filled. (There is insufficient blood in the body to properly fill the arteries if they are all widely dilated (see page 4), the pulse becomes soft, the temperature falls and syncope finally ensues.

Criles' exhaustive experiments[25] would seem to show that SURGICAL SHOCK is caused by exhaustion of the vasomotor centers, which renders them unable to maintain the normal tone of the vessels, so that the pressure falls often to a point sufficient to endanger life.

(24) Krehl, loc. cit.
(25) Blood Pressure in Surgery.

CHAPTER V.

BLOOD PRESSURE IN DISEASES OF THE HEART.

IN VALVULAR LESIONS.

In the study of the valvular disease of the heart the results do not seem to have special bearing upon the primary condition (defective valve) except in cases of aortic regurgitation. This is in part due to the usual complicated nature of the condition, which often includes arterial and myocardial changes and involvent of the kidneys.

The chief value of the sphygmomanometer in the study of heart conditions applies to the condition of the myocardium, to a demonstration of the effect of therapeutic measures, and as a guide in prognosis and in the general management of cases. With it we are able to determine with considerable accuracy the benefit derived from the drugs and other measures employed. In this we may guard against insufficient or improper treatment and also against the over use of these same measures by demonstrating the therapeutically efficient dose and the proper interval of its exhibition.

AORTIC REGURGITATION.

The blood pressure test may be sufficient to establish a diagnosis in pure aortic regurgitation, the great pulse pressure occurring in this condition being almost pathognomonic. Referring to the physics of the circulation we find that in aortic regurgitation the left ventricle is called upon to deliver an abnormally large volume of blood into the aorta to supply the demands of the circulation. This is because the heart is required not only to furnish sufficient blood for the needs of the body, but must also inject into the aorta at each systole enough surplus to compensate for the regurgitation of a large volume of blood into the left ventricle during diastole. The natural result of the sudden injection of this large amount of blood into the arterial system will be to cause a sudden and great rise in systolic

blood pressure (immediately succeeding systole, the blood disperses in two directions, forward through the capillaries and backward into the ventricle, producing the phenomenon of the water-hammer pulse). Thus the pressure rapidly falls and the diastolic pressure is abnormally low. *The combined result of this high systolic and low diastolic pressure is a great pulse pressure.*

In the presence of moderate or high grade generalized arterio-sclerosis this phenomenon is further accentuated because of the lack of normal elasticity in the arterial system tends to reduce the diastolic pressure to zero.

CHRONIC MYOCARDITIS.

The sphygmomanometer is a most valuable means of detecting alterations in the musculature of the heart, or before the development of the usual physical signs. Myocardial degeneration may be demonstrated by searching for *evidence of slight irregularity in rhythm and force and by the use of the work test.*

1—IRREGULARITY OF FORCE AND RHYTHM.

Alterations in the normal musculature of the heart causes a disturbance in the force and rhythm of the pulse. These changes when marked are easily discovered by the methods of palpitation and ausculation, but when slight are less easy of detection by the usual means. It is then that these variations may be intensified and so more easily detected by the sphygomanometer.

A study of the weak and thready pulse which appears at the wrist just after the pressure in the cuff has been reduced slightly below the systolic pressure in the vessel will accentuate any slight differences in the strength and regularity of the impulses. When the pressure approaches the diastolic it will be noted in cases of defective myocardium that the fluctuation of the mercury column is irregular because of this irregularity in the force and volume of the pulse.

2—WORK TEST.

BENDING MOVEMENTS.[26] In the application of this test it is important to have the conditions surrounding the ob-

(26) Personal communication from Dr. Francis J. Dever.

servation as uniform in detail as possible. Care in this matter will eliminate accidental variations and possible error arising from adventitious causes which might otherwise invalidate the test.

The following directions are suggested to insure accuracy and uniformity of the findings.

Sufficient time should always elapse after any exertion, such as a long or rapid walk or after climbing a flight of stairs, to permit the circulatory system to regain its normal condition before applying the test. Mental excitement from any cause, such as other examinations of the patient or apprehension of the approaching test, should be eliminated as far as possible. The patient should be sitting at ease, avoiding positions that might cause muscular strain. The test should be made with despatch, to prevent changes in pressure resulting from prolonged compression by the cuff. (See page 23.) The patient should be instructed carefully in the nature of the test and technic of the bending movements so that they can be correctly carried out without a number of unsuccessful attempts. Throughout the observation the cuff should be allowed to remain on the arm, so that the second reading may be made without delay after the exercise.

The patient should occupy the same position during the second observation as in the first.

THE BENDING MOVEMENTS.

These are ten in number and should be made in rapid and regular succession. The patient should stand erect with the feet together and hands held high above head, palms forward and thumbs locked. The body is then flexed at the hips in an effort to make the fingers touch the toes without bending the knees. The patient then recovers. This movement should be carried out ten times vigorously in rapid succession and the second blood pressure test made immediately.

INFORMATION OBTAINED BY THE TEST.

In the normal healthy individual, without myocardial or arterial disease, it will be found that if, for example, the systolic pressure be 130 before the exercise, it will rise to 135 or 140 millimeters, falling again within two to four minutes to the original level. This return to normal

may be so rapid that the temporary rise will be missed if the second observation is not made without delay.

If both the systolic and diastolic readings are taken, it will be noted that during this temporary rise in pressure the pulse pressure will also be greater.

In the case of a weakened myocardium, this temporary rise in pressure will not occur; on the other hand there will be a distinct fall with a diminished pulse pressure, at the same time the pulse will frequently be found to have become irregular.

CAUTIONS.

It is not advisable to apply this test to patients with excessively high blood pressure, in those of apoplectic tendency, or in those with high grade arterio-sclerosis. The test is unsafe in those with a systolic pressure of 200 millimeters or over. In such cases there is danger of ocular or cerebral hemorrhage or acute dilitation of heart.

The test will be difficult if not impossible of application in women unless all tight clothing is removed.

Valvular disease is not necessarily a contra-indication to this test, as the condition of the myocardium seems to be the only important factor, except in aortic regurgitation with high pressure, so that the presence of valvular lesions need not detract from the value of the information obtained by this test.

TACHYCARDIA.

Some cases of tachycardia with demonstrable heart weakness may be the direct result of the hypotension. This is seen in advanced arterio-sclerosis, in shock and after large doses of alcohol, choral and veratrum viride, and as the result of the toxemias of typhoid fever and tuberculosis.[27]

ANGINA PECTORIS.

Reports by Russell and others seem to indicate that there is not necessarily any elevation in pressure in the interval of attacks. The coincidence of generalized arterio-sclerosis, which is one of the causative factors in the production of this condition, will affect the pressure according

(27) G. W. Norris, U. of P. Med. Bull., April, 1903.

to the location and extent of the arterial change. (See page 29.) A rise occurs shortly before or coincident to the attack of pain, passing again when the pain ceases.

It should not be forgotten that cases of undoubted angina pectoris will be encountered in which there can be demonstrated no elevation in pressure either in the interval or during the attack.

It has been also shown that in certain cases accompanied by a constantly high blood pressure, the attacks may be lessened in number and severity, or even prevented by prophylactic measures directed toward a reduction of the high pressure.[28]

(28) Russell, loc. cit.

CHAPTER VI.

CARDIO-VASCULAR RENAL DISEASE.

Clinical experience has demonstrated that the conditions of arterio-sclerosis and chronic interstitial nephritis are with difficulty treated as separate and distinct conditions. Their corelation is so frequent that we have come to look upon the contracted kidney of chronic interstitial nephritis as but the terminal stage in arterio-sclerosis.

In the study of these phenomena it is of the utmost importance to recognize that arterio-sclerosis *per se* need not and frequently does not imply a pathologic elevation in blood pressure. Cases have come under observation in which evidence of arterio-sclerosic change in the radials was most marked, yet the sphygmomanometer findings showed no evidence of hypertension—in one case hypotension was found.

This variation from the usual conception of the state of the blood pressure in arterio-sclerosis is due to the fact that this condition does not always manifest itself as a generalized change more or less evenly distributed throughout the arterial tree. Thus it is evident that a local arterio-sclerosis appearing in the radials (and it is by palpitation of the radials or other superficial vessels that a diagnosis is usually made) might not and probably would not be accompanied by any change in blood pressure.

In arterio-sclerosis involving the aorta, the loss of elasticity in that vessel would tend to produce a moderate rise in pressure, while involvment of the splanchnic area in the arterio-sclerosis on account of their great area and their close relation in the maintenance of normal blood pressure would, without doubt, be accompanied by marked and permanent elevation in pressure, even when not accompanied by vascular disease in other quarters.

The anatomic changes found in the kidneys is the result of interference in their nutrition incident to alterations in normal blood supply and normal blood pressure

This disturbance of kidney function occurring in the course of arterio-sclerosis forms a link in a vicious circle which by adding to the already circulating toxins, tends to further elevate blood pressure.

As the direct result of the heightened pressure generally found in cases of arterio-sclerosis the pulse is usually spoken of as "high tension," "incompressible" or "hard." Associated with this we find the well-known urinary findings of chronic interstitial nephritis and usually an accentuated aortic second sound.

PATHOLOGIC ANATOMY.

The change affecting the arteries is a permanent one and is the outcome of the combined action of circulating toxins and the continued high pressure. These consist of:[29] 1.—A marked thickening of the tunica media due to hypertrophy of the muscular fibers. 2.—A thickening of the intema due to hypertrophy of the connective tissue. 3.—In some cases, a distinct hyperplasia of the adventitia. Except in case of local arterio-sclerosis, these changes are found quite evenly distributed throughout the arterial system in the cerebral, coronary and renal vessels, for example.[29]

MODE OF PRODUCTION OF ARTERIO-SCLEROSIS.

As a result of auto-intoxications from over-eating or from syphilis, lead poisoning, etc., there occurs in the circulating blood certain toxic substances or "muscular excitants," as they are termed by Huchard. These by their irritating nature stimulate the arteries to hypertonic contraction, and a narrowing of the blood vessels, particularly the smaller arteries and arterioles. This general narrowing of the blood path produces an elevation in blood pressure, so that palpation and tests with the sphygmomanometer show distinct evidence of this change. If these muscular excitants are continuously present the hypertonus and elevated blood pressure will be continuous, and the amount of the former determines the amount of the latter. If this vascular hyper-contraction last a sufficiently long time, it induces primary and secondary changes in the vessel walls, which continues and further augments the

(29) Russell, loc. cit.

effect upon blood pressure. In advanced cases this elevation of pressure may amount to from 200 to 250 per cent. above the normal. This great and continuous elevation occurs in no other pathologic condition, which does not include the complication or terminals of arterio-sclerosis, except possible aortic regurgitation and here it is difficult to rule out arterio-sclerosis on account of frequent coincidence of this disease.

The sphygmomanometer is of great value in studying the conditions of the circulation in cardio-vascular renal disease, particularly in the early stages, when it often furnishes the warning of grave danger. Often the individual is unaware that he has departed in any way from the normal. *High pressure accompanied by small amounts of albumen and the occasional appearance of casts, is strong evidence in favor of permanent kidney change.* In cases presenting only slight or no alteration in the normal blood pressure, but with a suspicion of chronic nephritis, it will be necessary before establishing a diagnosis to eliminate the deceptive conditions which may be due to constipation and auto-intoxications. (See page 31.)

In the absence of any definite physical signs which point to kidney involvment, but with a continuously elevated blood pressure, which cannot be otherwise accounted for, we are justified in strongly suspecting chronic interstitial nephritis.

In the average case of moderate duration the blood pressure readings will range between 160 and 290 mm.Hg. or even higher. The height of the pressure will be practically continuous except for minor fluctuations caused by constipation, auto-toxemias and the usual physiologic factors. (See page 26.)

In primary acute Bright's disease occurring in the course of scarlet fever there is practically always a sudden and marked rise in pressure. Buttermann[30] has noted a rise of as much as 50 mm.Hg. occurring in 48 hours after the onset of an acute nephritis. In advanced nephritis the detection of further sudden elevations will indicate the urgent necessity for immediate reduction in pressure to pro-

(30) Archl. f. klin. Med. vol. lxxiv. p. 1.

tect the cerebral vessels from rupture or the occurrence of oedema of the brain and coma.

UREMIC DISTURBANCES.

The routine use of the sphygmomanometer in all cases of nephritis is as important as the routine examination of the urine. Approaching uremic crisis are usually indicated by a sudden and marked rise in pressure often before they become evident in any other way.[31] In cases of contracted kidney a sudden fall in pressure indicates the giving out of the heart.

In the sphygmomanometer we have a practical and accurate means, not only of assisting materially in the diagnosis of cardio-vascular renal disease, but by furnishing early warning of impending danger we are enabled to institute prophylactic treatment.

CEREBRAL HEMORRHAGE.

In the majority of cases of cerebral hemorrhage we have to deal with cardio-vascular renal disease in which the involvment of the cerebral vessels is but an incident (usually terminal) in the general arterio-sclerosis change. Recognizing this intimate relation between these conditions it seems almost unnecessary to note that the control of the high pressure is the most essential feature in the management of cases with an apopletic tendency.

The sphygmomanometer furnishes the evidence which calls for appropriate preventative treatment, the success of which may be followed from time to time by noting its effect upon blood pressure.

From a study of 16 cases of cerebral hemorrhage by C. W. Sawyer,[32] the following conclusions were arrived at:

1.—Patients with kidney lesions which will not respond to treatment or whose blood pressure will not lessen are liable to fatal attacks of uremia.

2.—Nephritic patients with increasing blood pressure are especially liable to cerebral hemorrhage.

3.—A second hemorrhage, with a hemiplegia due to hemorrhage already existing, but with no kidney lesion, is usually fatal.

(31) H. Engel, Berlin, Klin. Wochen. Oct. 23, 1908.
(32) Ohio State Med. Jour. Nov., 1908.

4.—Patients with nephritis and increased blood pressure are as likely to succumb to a second hemorrhage as live.

OCULAR HEMORRHAGE.

Fox and Batroff[33] report in detail a study of one hundred consecutive cases of ocular hemorrhage in which the blood pressure test was employed.

In 80 per cent. of these cases hypertension was encountered. In 40 per cent. of the cases of retinal hemorrhage were accompanied by chronic interstitial nephritis. Arterio-sclerosis was present also in 27 per cent. and parenchymatous nephritis in 13 per cent.

These authors are convinced that increased arterial tension are an important factor in the causation of other ocular conditions, as acute glaucoma.

In the series of 100 cases 73 were cases of retinal hemorrhage. The average pressure for the series was above 160 mm.Hg. The highest recorded being 265 in a case of interstitial nephritis showing albumen and casts. 26 cases had a pressure above 200 mm.Hg. 26 were between 150 and 200 and 18 below 150. Thus 66 of the cases showing the direct effect of the elevated blood pressure (ocular hemorrhage) all showed arterial or kidney degeneration and a large proportion showed a distinctly pathologic elevation of blood pressure.

Further discussion seems unnecessary to emphasize the importance of the evidence furnished by the blood pressure test. It is invaluable in corroborating suspicions and confirming diagnosis, and by the early detection of elevated pressure, giving the patient a better chance of prolonging life and preserving sight by the institution of proper and adequate treatment.

EXOPHTHALMIC GOITRE.

Norris[34] notes that instability of the blood pressure in which there occurs frequent and irregular alterations between normal and hyper- and hypotension occurs notably in exophthalmic goitre. This condition has also been reported by L. F. Baker.[35] These alterations, particularly

(33) Colorado Medicine, May, 1909.
(34) G. W. Norris, loc cit.
(35) Jour. A. M. A., Oct. 12, 1907.

toward hypotension may be related to the tachycardia found in this disease either as cause or effect.

ECLAMPSIA.

As might be supposed from the clinical manifestations of eclampsia and its evident relation to altered metabolism, particularly of the kidney, the retention of the waste products of metabolism and probably the development of specific toxins, the blood pressure is uniformly and markedly elevated.

Routine blood pressure observations should be made a part of the periodic examination of pregnant women, the intervals between the tests becoming shorter as the period of gestation advances; nor should the test be omitted during the puerperium, as the danger from eclampsia does not terminate with the evacuation of the uterus.

According to G. S. C. Badger[36] the blood pressure is always high after the onset of the condition, when it becomes of prognostic importance. For, if in spite of improvement in the subjective symptoms and an increase in the quantity of urine the pressure remains high, then the prognosis is grave and labor should be induced without delay. After emptying the uterus if the pressure remains high the prognosis is grave as to complete recovery.

R. C. Davis[37] has found an increase in pressure in all cases of eclampsia coming under his observation. In the treatment of such cases a coincident reduction in the amount of albumen in the urine is noted with the reduction in blood pressure.

In his experience the most successful method of treatment has been the employment of blood pressure reducers and toxin eliminators, foremost among them being the hot pack and vapor bath.

DIABETES.

Arthur B. Elliott[38] reports a series of 150 observations upon 25 diabetics of all ages. He found the diastolic pressure hard to obtain. The cases, complicated with cardiovascular renal disease, represented 20 per cent. of the 25 cases reported. In these the systolic pressure was marked-

(36) Boston Med. and Surg. Jour., May 9, 1908.
(37) U. of P. Med. Bull., May, 1908.
(38) Jour. A. M. A., July 6, 1907.

ly higher than in the cases not so complicated. Hypotension seems more prone to develop in cases showing acid intoxication. Diabetes *per se* does not seem to have any marked effect upon the blood pressure level. Cases showing more than three per cent. of sugar showed a slightly greater tendency toward the subnormal than those showing less than this amount.

SUMMARY OF SYSTOLIC PRESSURE RECORDS.

Number of cases	25	
Average age	45	years.
Male	13	
Female	12	
Average weight	156	pounds
Average systolic blood-pressure	127	mm.Hg.
Average of cases showing 3 per cent. sugar	121	mm.Hg.
Showing less than 3 per cent. sugar, pressure average	135	mm.Hg.
Number of cases developing acid intoxication	10	
Average systolic pressure	107	mm.Hg.
Number of cases not showing acid intoxication	15	
Average systolic pressure	140	mm.Hg.
Number of cases, showing indication of arterio-sclerosis and kidney involvement	5	
Average systolic pressure	164	mm.Hg.

CHAPTER VII.

INFECTIOUS DISEASES.

SCARLET FEVER.

The blood pressure shows a moderate rise at the onset of the disease and thereafter follows closely the pulse and temperature curve. After the seventh or eighth day the pressure may be below normal. Complications have a marked effect upon blood pressure. Cases showing albumenuria generally show hypertension. This rise in pressure is accompanied by slowing of the heart's action. (See page 35.) With the subsidence of the kidney irritation the pulse rate increases and the blood pressure returns to normal.[39]

DIPHTHERIA.

The pressure is generally lowered during the active stage of this disease, the amount depending largely upon the degree of toxemia. The administration of strychnine and alcohol annul this fall only when given regularly. The administration of antitoxin, while usually causing a brief rise in temperature, has no effect upon the blood pressure.[39]

TYPHOID FEVER.

Here the blood pressure is usually considerably lowered, the hypotension increasing with the duration of the disease and gradually disappearing with the establishment of convalescence. It may be abruptly terminated by the intercurrance of complications, such as pneumonia or peritonitis. Large or repeated hemorrhage will, of course, tend to produce a fall in pressure.

ACUTE INFECTIONS.

In general have but little if any effect upon blood pressure. In many there may be a slight fall during the height of the invasion, which rapidly subsides as the infection is overcome.

(39) J. Davidson, Lancet, Oct. 19, 1907.

MISCELLANEOUS CONDITIONS.

NEURASTHENIA.

As might be expected from the character of the condition, considerable irregular variation will be found in the reading in this condition, due in all probability to the general instability of the nervous system which is unable to exercise proper control over the blood pressure regulating mechanism. The reading may be higher than normal, but usually lower. Treatment, when successful, may leave the patient with a different normal level from that existing before treatment was begun.[40]

In differential diagnosis between true neurasthenia resulting from exhaustion of the nerve centers and its accompanying low pressure, from a similar symptom complex due to the absorption of toxins from the digestive tube and in which the blood pressure is high, the blood pressure test is invaluable.[41] Obviously such a differentiation is absolutely essential since the treatment of the two conditions are diametrically opposite.

POLYCYTHEMIA.

There has as yet been found no definite relation between the high blood pressure and an increase in the number of red corpuscles. Moller[42] examined 25 apparently normal individuals with high blood pressure and in two only did he find an unusually large number of red corpuscles.

In LEAD COLIC and in beginning peritonitis, statistics show that there is generally an elevation in blood pressure.

In CHOLERA the rapid reduction in the volume of blood incident to the diarrhoea causes a marked reduction in the blood pressure.

At the MENOPAUSE the same instability in the pressure as noted in exophthalmic goitre is encountered.

(40) E. D. Macnamara, Lancet, July 18, 1908.
(41) L. Williams. Clinical Jour., London, Jan. 8, 1908
(42) Deutch. Med., Wochen., Oct. 28, 1908.

CHAPTER VIII.

THERAPEUTICS.

The study of blood pressure frequently furnishes the key to proper treatment in a number of diseases; it also furnishes a reliable guide as to the efficiency of the resources employed, as well as the time during which treatment should be continued.

It is not within the scope of this little work to more than touch upon a few of the most important points in the relation of blood pressure to the management of disease.

The general symptoms accompanying diminished blood pressure indicate in no uncertain manner the necessity of tonic treatment. In cases of emergency with suddenly falling pressure and evidence of collapse, adrenalin intravenously or hypodermatically is indicated.

For the sudden drop in blood pressure occurring in advanced arterio-sclerosis, digitalis is indicated, provided there is no evidence of marked myocardial degeneration, in which event strychnine is the safer drug to use.

In lowered blood pressure from hemorrhage or profuse and prolonged diarrhoea the pressure is the best indicator of the amount and the frequency for the use of saline infusion or the Murphy treatment.

Albumen appears in the urine whenever the kidneys are passively congested and its importance, when due to this cause, is often greatly exaggerated. Albuminuria associated with kidney disease is nearly always accompanied with elevation in blood pressure; albumen when due to other causes is not usually so accompanied.[43] As these two causes of albumenuria demand almost diametrically opposite treatment, their differentiation is of the utmost importance.

A similar differentiation is necessary in the separation of true neurasthenia, caused by exhaustion of the nerve centers, accompanied by low pressure from a corresponding symptom complex due to absorption of toxins from the digestive tube, and in which the blood pressure is high (see page 50).

(43) L. Williams, loc. cit.

Post-influenzal conditions demand a similar differentiation. In the lowered pressures stimulating, tonic and hypernutrient treatment is demanded, while in the high tension cases relaxation, sedation and limited feeding is indicated. Failure to make this distinction may be fraught with disaster.[44]

High pressure in the apoplectically inclined calls for active and continued pressure reducing treatment. Among the drugs which are generally depended to accomplish this change are the nitrites, of which a freshly prepared solution of sodium nitrite will be found the most serviceable, being easy of administration and prolonged in action.

In the treatment of aortic aneurism with high pressure, the use of blood pressure reducing agents may materially prolong life by reducing the tendency to rupture and at the same time afford relief from the most distressing symptom—pain, by lessening the tension in the aneurismal sac, thereby relieving the nerve irritation and the pressure upon surrounding organs or tissues. In one case of this character, occurring recently in the service of Dr. Judson Daland, the patient was relieved promptly and almost completely, while hemoptesis was checked by the administration of sodium nitrite, given prior to the operation of wiring the sac. During the introduction of the wire, which was done by the aid of local anesthesia, a close observation of the blood pressure enabled a minimum pressure to be maintained, thereby greatly reducing the chances of sudden rupture of the sac, and by reducing the force of the circulation favoring the formation of a clot.

In acute Brights, after failing to reduce the pressure by the usual measures, it may sometimes be controlled by the electric light sweat bath. In one case a reduction of from 20 to 40 millimeters was obtained, the beneficial effects lasting for many hours, so that regular observation of the pressure determined the proper interval between the sweats.

By a regular blood pressure observation we may determine the maximum efficient dose of many cardiac remedies, and to follow their action with greater accuracy than by the usual physical measures.

After all the value of the usual drugs which have been

(44) L. Williams, loc. cit.

supposed to effect blood pressure has been disappointing in the light of the blood pressure test, even the nitrites and potassium iodide being very uncertain in action, often failing to have any effect when most needed.

A. E. Mills[45] after careful and critical tests, reaches the same conclusion and suggests the use of opium or its derivative morphia, which he asserts is of particular value in arterio-sclerosis with high pressure. He cites two cases of arterio-sclerosis with granular kidney in which the dyspnoeic symptoms and the high pressure were promptly relieved by the hypodermic administration of morphine. The blood pressure in one case falling from 220 to 178 millimeters within an hour, and in the other from 200 to 170 in less than half an hour. In the first case a quarter grain of morphia was given, followed at intervals of fifteen minutes by two-eighths.

In cases of arterio-sclerosis, Lauder Brunton[46] recommends trying sodium iodide, ten grains a day, for a long time, also ammonium and sodium hippurate, sodium benzoate, sodium nitrite or potassium bicarborate.

When the heart begins to fail with irregularity and intermissions in the pulse, dizziness, inability of exertion, dyspnoea and oedema of the ankles, a combination of cardiac tonics with vaso-dilators is indicated; the diet and drink is to be restricted and rest comparative or absolute enjoined. Flatulent distention in these cases is often relieved by the following mixture:

Rx.

Liquor trinitrinis, m. ss. to iii.
Spts. ammon. aromatic, m. xv. to lx.
Spts. chloroformi, oz.
Spts. aeth. comp., m. v. to x.
Tinct. card. comp., m. x. to xxx.
Aq. meth. viridi, qs. oz. i.

Mise.

Sig. This draught to be repeated every fifteen minutes until relieved or until the trinitrin causes dizziness. Inhalations of chloroform, ethyl idodide, or subcutaneous injections of morphine may be necessary.

(45) Australasian Medical Gazette, Jan., 1908.
(46) Lauder Brunton, loc. cit.

DIET IN CARIO-VASCULAR RENAL DISEASE WITH HIGH PRESSURE.

Proteid food, particularly meat, should be limited and the diet composed chiefly of bread, vegetables, fruit, butter, milk and fat bacon.

Alcohol, tea, coffee and tobacco should be taken sparingly if at all. Little fluid should be taken with meals; plain water, hot water or mineral water, hot or cold, may be taken freely about three hours after eating.

Moderate exercise without strain is beneficial, but strain either mental or physical must be absolutely avoided. Light mental work in moderation is good, but irritation and emotional disturbances are bad.

Constipation must carefully be avoided.

CHAPTER IX.

IN SURGERY.

The sphygmomanometer has many applications in surgery. The safety of anesthesia is increased by the frequent application of this test during all prolonged operations. By it an impending shock is easily detected, often before the usual signs develop. Thus regular and frequent tests of the blood pressure, before, during and after operations, will serve to indicate the need for stimulation, etc.

As an indication for venesection, saline infusion or the Murphy treatment, and as a guide to the beneficial effect of these several measures, the sphygmomanometer is pre-eminent.

A few observations have been reported where the use of the blood-pressure test has been of great value in certain surgical conditions. As in wiring aneurism, in operations upon cases suffering from shock, in eye surgery and in operations involving the pleurae.

In the case of aortic aneurism above referred to (page 52) the patient was prepared for operation by the preliminary administration of sodium nitrite until no further effect upon blood pressure could be obtained. During the process of wiring constant observation of the blood pressure indicated with great certainty the need for further nitrite and for the administration of stimulants.

In direct transfusion the test made upon both the patient and the donor furnishes a reliable guide of the safe length of the operation.

In eye surgery the following reference from L. Webster Fox is significant and suggests great possibilities for the test in the treatment of eye conditions associated with hypertension:[47] "It was interesting to note that in one case of acute glaucoma where the blood pressure was 265 mm.Hg., 20 ounces of blood taken from the right arm when the pressure fell to 150 mm.Hg. This patient had an attack of acute glaucoma in the right eye two years before.

(47) L. Webster Fox, loc. cit.

An iredectomy was performed by a skilled operator, but it was not successful. The blood pressure was evidently so high that the eye was lost by an immediate intra-ocular hemorrhage and collapse of the eyeball. When the patient came under my care for a similar attack in the left eye there was tension of plus three and more and vision was gone for two days. I concluded that a reduction of tension in the eyeball must be obtained somehow before a successful iredectomy could be performed. Eserine failed to make any impression upon the dilated pupil or the tension within the eyeball. It was interesting to note the condition of the pupil after ten ounces had been withdrawn from the arm; it had commenced to contract and by the time that 20 ounces were taken the tension (pressure) fell to 150 mm.Hg, the pupil contracted to a pinhole and the tension in the eye was about normal. I was able to perform the iredectomy without untoward result and useful vision followed." While this is but an isolated case it serves to show very beautifully what may be done by an intelligent appreciation of the effects of heightened blood pressure and what measures may be employed for its successful reduction.

Capps and Lewis[48] arrive at one very significant and instructive conclusion in regard to the relation of certain vaso-motor reflexes and surgical procedures involving the chest.

They note that following aspirations of pleural effusions there frequently occurs a marked fall in blood pressure accompanied by unfavorable symptoms. They concluded that these could not be entirely accounted for by the changes occurring in intra-thoracic pressures, and that the effects were due to the operation of two types of reflex, one cardio-inhibitory and the other vaso-dilator; the latter simulating shock may be so profound as to be fatal. These reflexes are very prone to occur during operative procedures upon inflamed pleurae.

For emergency in the treatment of this condition adrenalin intra-venously is indicated. Atropine is of little value and may even do harm.

They suggest the following precautions as preventative measures: The instruments used should be allowed to irritate

(48 J. A. Capps and D. Lewis. Am. Jour. Med Sci., Dec., 1908.

the pleura as little as is absolutely necessary; the projection of long drainage tubes within the pleural cavity is particularly to be avoided; swabbing the pleural surfaces is dangerous and to be condemned.

Finally they emphasize the importance of taking the blood pressure test before and after all operations on the pleural cavity in order to foresee and thereby prevent the development of these dangerous blood pressure reducing reflexes.

CHAPTER X.

LIFE INSURANCE EXAMINATIONS.

The sphygmomanometer is an invaluable aid in the examination of applicants for life insurance, particularly those above 35 or 40 years.

A general knowledge of the subject of blood pressure should be required of every insurance examiner, who should be particularly familiar with the relation of blood pressure to those conditions most likely to be met with in the applicant for life insurance. These are chiefly those of the cardio-vascular system and kidneys. (See page 42.)

A very important reason for the general adoption of the blood pressure test in life insurance is the fact that even the most experienced clinicians find it very difficult, if not impossible, to accurately estimate blood pressure by palpitation of the radial. To quote again from William Russell[49] we find the following a very significant statement: "I must, however, again add a warning note to the effect that . . . . feeling the radial is not always a reliable guide as to what the bracial pressure will read . . . . I have two such cases under observation as I write this; the radial artery in neither being hard or incompressible and yet in both there is a steady reading of over 200 mm.Hg."

From the evidence found in the statistics of life insurance companies it is plain that this test is of greatest value in just those conditions which show a high and increasing mortality. In one company the deaths from apoplexy, nephritis and organic heart disease amounted to 25.1 per cent. of all the deaths occurring during the past nine years. The percentage of deaths from apoplexy have increased from 7.0 per cent. in 1900 to 9.5 per cent. in 1908. Organic heart disease has advanced from 8.6 per cent. in 1900 to 9.3 per cent. in 1908. Nephritis (chronic) remains about the same.

(49) W. Russell, loc. cit., page 75

It is even more difficult to fix hard and fast rules for the guidance of the insurance examiner than it is for the clinician, because of the frequent mental perturbation in applicants. This difficulty may frequently be abrogated by repeated examination, which allows the applicant to become more familiar with and hence less disturbed by the examination.

In a number of personal communications received by the author from some of the large life insurance companies in the United States and Canada, it was a significant fact that with but few exceptions all the companies advocated the use of the sphygmomanometer in selected, if not in all cases. When any discrimination was made it was suggested that the test would be of greatest value in cases of suspected high tension where there was any suspicion of heart or kidney disease in applicants with a history of albuminuria or casts or in those subjected to severe or prolonged mental or physical strain, particularly if they had passed to 40-year mark. It would seem also to be indicated in overweights, because of the apparent susceptibility of such individuals to the causes of hypertension and the frequency of the occurrence of cardio-vascular renal disease in them.

PERMISSIBLE VARIATION.

Until more definite information accrues the limits laid down by clinical experience must be adhered to, bearing constantly in mind the modifying effect of age. (See page 25.) For example it would be unsafe to accept a man of 28 years with a constant pressure of more than 140 millimeters, unless the cause of the hypertension was explained, while the same pressure in a case over forty years would be looked upon with less mistrust.

The great frequency of the relation of alimentary hypertension makes it important to search for it and it is inadvisable to jump to the conclusion that all cases showing hypertension, particularly when occurring in young adults, is evidence of cardio-vascular renal disease. Careful search for confirmatory evidence should not be neglected before the risk is rated.

HIGH PRESSURE AND TRANSCIENT ALBUMINURA.

Probably the most confusing combination of symptoms met is the case which presents a slight hypertension and an occasional trace of albumen in the urine. These cases are best examined at the home or branch office and should be referred there whenever possible, for it is often only after the most careful and complete examination with repeated urine and blood pressure tests that a correct conclusion regarding the safety of the applicant can be reached.

If after eliminating the possibility of an alimentary hypertension a distinct elevation in pressure remains with albumen in the urine, even in occasional and minute traces, the risk is doubtfully good, while if accompanied by accentuation of the aortic second sound or casts the risk is bad and calls for rejection.

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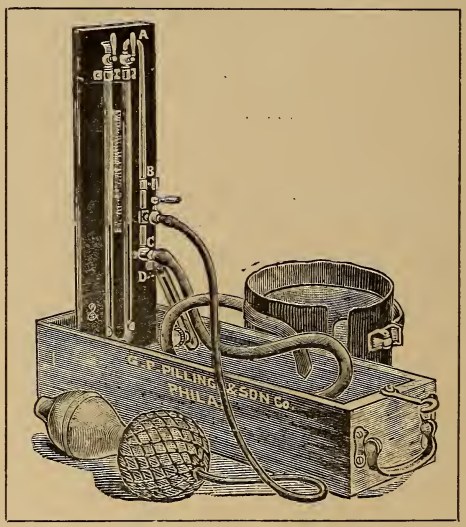

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